

# The Evolution of Textbook Illustrations in Probability & Statistics: a Comparison

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## 1. Research Questions

RQ1. How did the type, amount, and purpose of illustrations change between the two editions for the same topic?

RQ2. What patterns emerge when comparing the use of illustrations across topics for the same book?

## 2. Related Work

- **Color became a standard tool** (Mulcahy & Samuels, 1987): the development of printing technology allowed for higher quality illustrations, shifting the industry to make colored printing the norm.
- **Figures change over time** (Dimmel & Herbst, 2015): they studied many geometry figures and found the style of figures changes over the years.
- **Adapting established frameworks** (Slough & McTigue, 2013; Bustamante-Valdés et al., 2024): we borrowed three ideas about caption quality, how close a figure sits to its text, and the type of a figure.
- **Technology changed statistics** (Moore, 1997): statistics moved from hand calculation to software.

The gap: there are limited studies comparing figures in university P&S textbooks across time.

## 3. Methodology

- **Same-author design.** One book, one author, two editions 34 years apart: Devore's *Probability and Statistics for Engineering and the Sciences*, 1st (1982) vs. 9th (2016). Holding author, book, and audience constant isolates the reason for the changes.
- **Corpus:** 103 figures across the three chapters with the largest growth in figure count: Descriptive Statistics, Joint Probability, Linear Regression.
- **Thematic analysis.** Iterative open coding in ATLAS.ti; an abductive codebook pairing deductive codes from existing frameworks with inductive codes for new P&S features.
- **Nine codes per figure:** illustration type, communicative function, text-illustration relationship, caption quality, spatial contiguity, text reference, features, color, and software output.

## 4. Theme: Elaborate Figures, Tighter Text Integration

The 9th edition figures are visually more detailed, yet they mean less without the surrounding text than the 1st edition figures.

- **More detail.** The 9th edition figures have more features such as labels, titles, and grids compared to the 1st edition.
- **Multiple connected figures.** Both editions put multiple figures into a single figure. However, the 9th edition uses more figures inside a single figure.
- **Shorter captions.** The 1st edition sometimes had no caption. The 9th edition always has one. But the caption just names the figure instead of explaining the contents of it.
- **Closer to the text.** 9th edition figures more often sit on the same page as the text that references them. This is less frequent in the 1st edition.
- **More explicit references.** The 9th edition reference text more explicitly points to the figure compared to the 1st edition.

Readers see all related data in one place with more context, preventing them from losing focus.

The text and figure are linked, so readers do not read the same explanation twice.

So the figures did not become easier to read on their own. The explanation of the figure moved out of the caption, and into the figure's features, labels and the referencing text.

## 5. Theme: From Showing Steps to Showing Answers

The old figures show how to get an answer while the new figures just show the answer.

- **Color marks the result:** The 1st edition is all black-and-white. The 9th edition adds colour. The 9th edition mostly recolors the lines of the plots. The rest of the plot stays greyscale, so reader's eye goes straight to the result.
- **A new type of figure:** The 9th edition uses figures that are copied from statistical programs like Minitab while the 1st edition does not contain any. The 9th edition uses them to present the finished result of a problem.
- **What did not change:** Figures showing step-by-step explanations did not disappear. The count held at 6 in both editions. The 9th edition kept them and added result figures on top.

The trade-off: software output shows the result, but not how it was found.

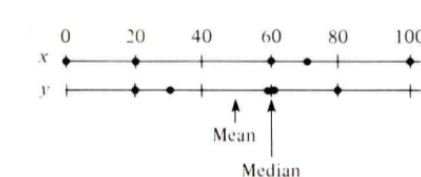


Figure 1.9 Data sets with the same center and differing variability

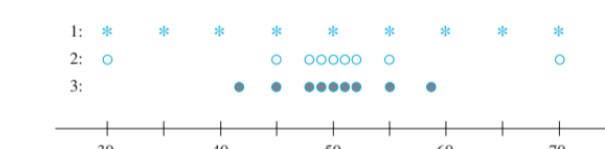


Figure 1.18 Samples with identical measures of center but different amounts of variability

1st Edition (1982)

9th Edition (2016)

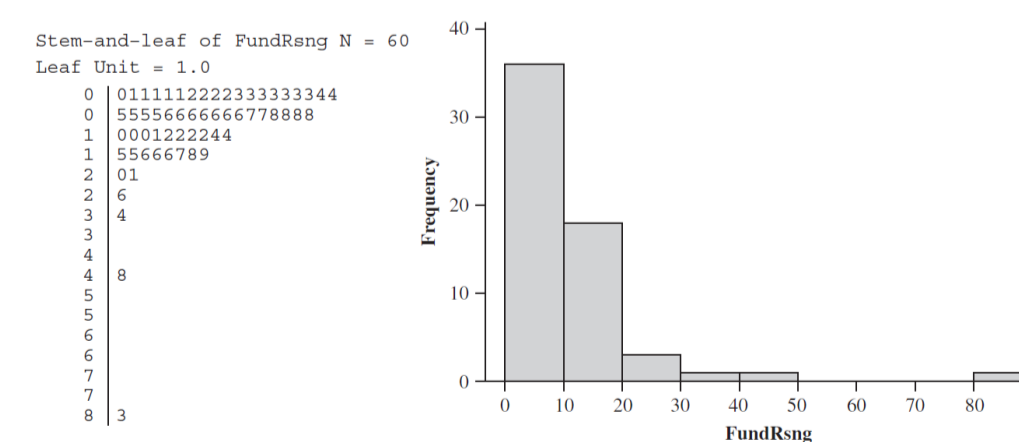


Figure 1.1 A Minitab stem-and-leaf display (tenths digit truncated) and histogram for the charity fundraising percentage data

Software Output Example

## 6. Theme: The Topic Decides the Figure

Each topic prefers a certain kind of figure and this did not change over time.

- **Descriptive statistics** uses data figures, like boxplots and histograms.
- **Joint probability** uses conceptual figures, like a shaded region one integrate over.
- **Regression** uses scatterplots that show a line through points.

The same topics used the same kinds of figures in both 1st and 9th editions.

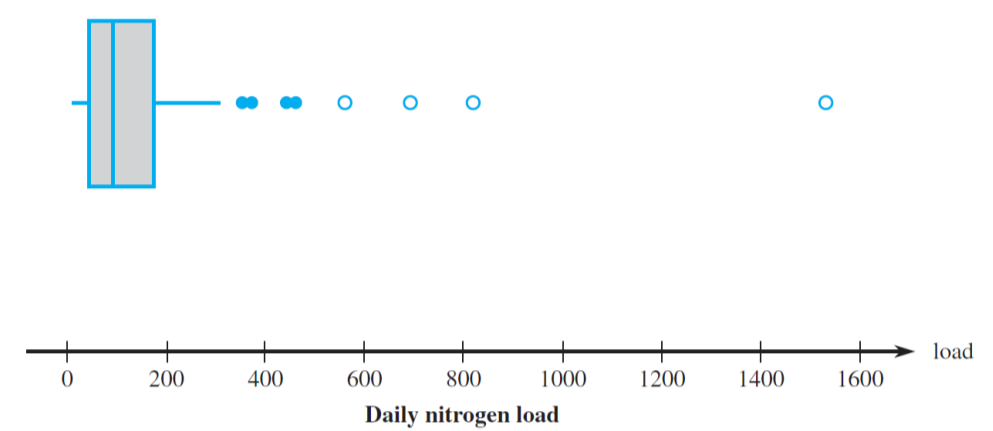


Figure 1.21 A boxplot of the nitrogen load data showing mild and extreme outliers

Descriptive Data

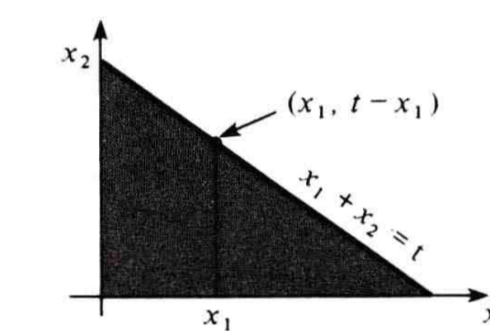


Figure 5.8 Region of integration to obtain c.d.f. of  $T_n$  in Example 5.13

Joint Probability

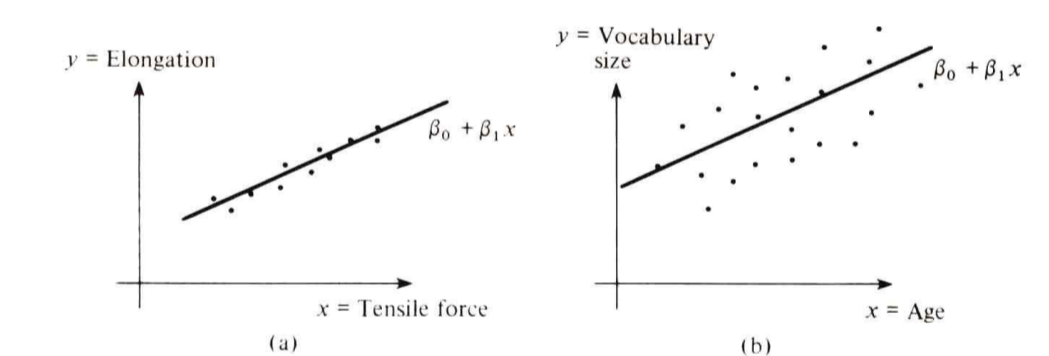


Figure 12.4 Typical sample for (a) small  $\sigma^2$ , (b) large  $\sigma^2$

Linear Regression

A surprise: While probability and statistics depend on figures a lot, it changed the least in terms of types of figures. For example, conceptual figures do not use any output from software, so technology affected the types of figures for each topic very little.

## 7. Discussion, Conclusion & Future Work

**What drove the change.** Two forces: (1) cheaper colour printing and digital typesetting made colour, extra features, and consistent layout easy; (2) statistics itself moved to software, so the book now teaches reading computed results rather than calculating by hand.

**Same-author caveat.** Fixing the book and author lets us attribute the changes more confidently to technology but an author's style can also shift across 34 years, so this reduces rather than removes that effect.

**Conclusion.** Modernisation changed how figures look, where they sit, and how much they lean on the text but not their underlying content or which topic uses which figure.

**Limitations:** one book, three chapters, a single coder.

**Future work:**

- Test whether "software output" figures help or hurt learning versus a worked hand-calculation.
- Code the in-between editions to date when colour and software output entered.
- Check whether the topic-figure pattern holds for other authors and books.
- Add a second coder and an inter-rater reliability score.